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Assessment of the Ambient Air Quality of Sangli City, Maharashtra, vis-à-vis National Ambient Air Quality Standards (NAAQS)

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Abstract

Assessment of ambient air quality is important to formulate short-term and long-term plans to mitigate air pollution. This study attempts to present an ambient air quality assessment for Sangli City, located at 16.85° N, and 74.58° E. The assessment is done through ambient air quality data measured over three ambient air quality monitoring stations located in residential, commercial, and industrial zones of Sangli City. The data was collected from 2009 to 2017 under the National Air Quality Monitoring Program of the Central Pollution Control Board (CPCB), India. The observed concentrations of gaseous pollutants, SO2 and NOx, and respirable particulate matter are compared with the concentration levels prescribed by the National Ambient Air Quality Standards (NAAQS) in 2009. The concentration levels of particulate matter are quite on the higher side of the prescribed standards. The levels of NOx are almost approaching the prescribed values, whereas SO2 levels are well within the margin. We have also studied seasonal variations in the pollutants during the study period. In general, the air quality in Sangli City is quite undesirable during the mid-winter to mid-summer period. The study is useful for common men to increase awareness. It also forms baseline data and is useful for local and central government to design appropriate strategies to apply corrective measures, protect health, and promote environmental protection.

Keywords: *AAQM, SO2, NOx, RSPM, SPM, NAMP.*

1. Introduction

Air pollution has been a serious issue the world over. In India, the major sources are industrial emissions, coal, wood, and biomass burning, solid waste landfills, automobile emissions, and traffic-related emissions and resuspensions. Due to its detrimental impacts on property, plant life, human health, and climate change, the poor quality of the air in metropolitan areas has become an increasingly pressing concern. The rising concentrations of gaseous pollutants and particulate matter (PM) are linked to an increased risk to health. The incidence of respiratory and cardiovascular disorders is strongly correlated with the rise in PM. The World Health Organization estimates that air pollution in India is responsible for over 1.2 million deaths each year in its World Air Quality Report, 2021 (https://www.iqair.com) [1]. PM also plays a significant role in climate change (Paasonen et al., 2013). There is an established relationship between PM and a reduction in visibility due to its interaction with solar radiation, rainfall patterns, and the formation of smog. The gaseous pollutants also affect human health and the environment. Numerous gaseous contaminants, such as CO, SO2, NO2, and O3, can build up and are associated with a lower lung fraction and respiratory illnesses. In many Indian

cities, including Delhi, Kolkata, and Mumbai, there has been a noticeable increase in air pollution in recent years. As per the World Air Quality Report 2023 (https://www.geeksforgeeks.org), Delhi ranks fourth globally in terms of pollution. Elevated levels of NOx and VOCs in the atmosphere are increasing concern due to their adverse health effects and their ozone forming potentials (OFPs) in urban environments (Weidong Yang et al., 2018, Leong et al., 2016). 80% of Indian cities are unable to meet the prescribed air quality standards and in almost 56% of these cities, the pollutant levels are nearly 1.5 times the permissible limits resulting in high mortality and morbidity. The Air (Prevention and Control of Pollution) Act was passed in 1981 and subsequently amended from time to time to regulate air pollution in India. Nonetheless, India was placed 180th out of 180 countries in the 2022 Environmental Performance Index (World Economic Forum, 2022). The 'Control of Pollution' is an ongoing scheme under the Central Sector Scheme that was initiated by the Central Pollution Control Board in the year 2018–19 with the approval of the Expenditure Finance Committee (EFC). Under the State and National Air Monitoring Program, India's Pollution Control Board now routinely monitors four air pollutants, namely sulfur dioxide (SO2), oxides of nitrogen (NOx), Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM-PM10). Two times a week, for a total of twenty-four hours, these pollutants are monitored (4 hours for gaseous pollutants and 8 hours for particulate matter). This results in 104 observations annually. The data pertaining to this is routinely made available on the CPCB website to understand the current air pollution status in India. Walchand College of Engineering, Sangli, is one of the agencies under NAMP to monitor the ambient air quality of Sangli city. In this study, the officially released data on PM and two gaseous pollutants (SO2, and NOx) at Sangli City during the period of June 2009 and June 2017 were gathered to compare the levels of pollutants vis-à-vis NAAQS during the study period. Although a few previously carried out studies report air quality at various cities in India (Muchate & Chougule, 2011; Kankal & Gaikwad, 2011; Sharma & Kulshrestha, 2014; Chauhan et al., 2016; Dadhich, 2018; Kumar & Dash, 2018; Kaushik et al., 2019), to the best of our knowledge, none of the studies analyzed and published gaseous and particulate concentrations for the study duration in order to give an overall idea of the air pollution status of Sangli city. The results of this study will be helpful in determining the annual variability of pollutants and evaluating the impact of previous and upcoming government-adopted control measures on pollutant levels. The study is also useful for common man to increase awareness as well as for local and central government to design appropriate strategies to apply corrective measures, protect health, and promote environmental protection (Nigam et al., 2016; Mamta and Basin, 2010; Kumar & Dash, 2018).

2. Experimental Methods or Methodology

The Maharashtra Pollution Control Board (MPCB) has administered air quality monitoring stations at various cities and towns in Maharashtra. This is being done as part of the National Air Monitoring Program (NAMP) through independent institutes that directly report to the MPCB. Walchand College of Engineering, Sangli, is one of the technical institutes operating in Sangli on behalf of MPCB since 2008. Sangli is a city and the district headquarters of Sangli District in the state of Maharashtra, in western India. It is spread over 118 km2 of reasonably flat terrain, with a population of 513,862 (Census: 2011). The current estimated population of Sangli Miraj Kupwad city in 2024 is 712,000, while the Sangli Miraj Kupwad metro population is estimated at 729,000 (https://www.census2011.co.in/). The city is located at 16.85° N, 74.58° E. The MoU was signed with

MPCB, Mumbai, on 3rd April 2008 for the establishment of three Ambient Air Quality Monitoring (AAQM) stations at Sangli under the State Air Quality Monitoring Program, which was subsequently transformed into the National Air Quality Monitoring Program (NAMP) in 2009[2]. In accordance with the same, three stations have been established: one at the terrace of Udyoga Bhawan, Sangli; a second at Krishna Valley School, Kupwad MIDC; and a third at Sangli Miraj Primary School at Rajawada Chowk, Sangli, in consideration of the MPCB guidelines for citing air quality monitoring stations. All the stations have been brought under the National Air Quality Monitoring Program (NAMP) and are allotted station codes. The details are presented in Table 1. All the AAQM stations (Table 1) are installed with Respirable Dust Sampler (RDS) APM 460 NL with gaseous attachment APM 411 TE; make Envirotech Instruments Pvt. Ltd. Delhi. Each station has been run twice a week for 24 hours by swapping the days over the study period [15]. Tuesday has weekly off. It is common practice to monitor four pollutants: oxides of nitrogen (NOx), sulfur dioxide (SO2), Respirable Suspended Particulate Matter (RSPM) and Suspended Particulate Matter (SPM). The sampling period for particulate matter and gaseous pollutants is eight hours and four hours, respectively [3]. The methods of measurement for the pollutants are identified in the ambient air quality standards laid down by CPCB under Section 16(2)(h) of the Air Act, 1981. SPM and RSPM are determined by the gravimetric method. NOx and SO2 are determined by the colorimetric method, viz., the modified Jacob and Hochheiser and the improved West and Gaeke methods, respectively. All the chemicals are of the analytical reagent grade, and standard practices (Guidelines for the Measurement of Ambient Air Pollutants, 2012–2013, Vol. 1) are observed during analysis [4]. The DR 6000 UV visible spectrophotometer, Make-Hach, Germany, is used for the analysis of gaseous pollutants [25 -27].

3. Results and Discussion

3.1 Comparison of Ambient Air Quality (AAQ) with National Ambient Air Quality Standards (NAAQS)

A typical data set of monthly average concentrations (µg/m3) observed at three AAQM stations located in Sangli is presented in Table 2. Similar data collected at all the air quality monitoring stations in Sangli during 2009–2017 is available on www.mpcb.gov.in/air-quality/sangli/0000000145 [24]. The data was reduced to a single annual average concentration value for RSPM, SO2, and NOx in order to compare it with respective NAAQS. The parameter Suspended Particulate Matter (SPM) includes RSPM. It primarily consists of coarse dust, carbon particles, fugitive ash, soot and similar matter induced due to local conditions which comes in the wake of air being sucked through hood of the RDS and may not be true representative of ambient air [5]. This matter is of coarser diameter, usually more than 10 µm, and has significant higher settling velocity; usually more than 0.3 cm/sec. As the particulate matter tends to settle in short duration it is not immediately harmful in the context of air pollution and hence it was intentionally removed. Furthermore, the study was intended to compare observed AAQ with NAAQS (2009) [22]. The Indian Government has taken several measures to mitigate air pollution which interalia include, Notification of National Ambient Air Quality Standards 2009, envisaging 12 pollutants (NAAQMS, 2012-13). The standard prescribes concentration for PM10, µg/m3 and PM2.5.

Table 1 Description of Ambient Air Quality Monitoring (AAQM) Stations at Sangli

Sr. No.	Station	Code	Observations		Type	Location
			To be taken	Actually taken		
1	Terrace of SRO, MPCB, Udyog Bhawan	574	104	104	Residential	16°51'10.11" N 74°35'40.98" E
2	Terrace of Krishna Valley School, Kupwad MIDC	576	105	105	Industrial	16°52'53.16" N 74°37'53.43" E
3	Terrace of Primary School, Rajwada Chowk	575	104	104	Commercial	16°51'39.52" N 74°33'52.29" E

Table 2 Ambient Air Quality Data for 2009–10 at Three Monitoring Stations In Sangli

Month	Udyog Bhawan (Residential)				Kupwad MIDC (Industrial)				Rajwada Chowk (Commercial)			
	SO_2	NO_x	RSPM	SPM	SO_2	NO_x	RSPM	SPM	SO_2	NO_x	RSPM	SPM
June 09	37	26	31	57	38	34	56	83	40	30	36	61
July 09	16	25	29	46	22	36	50	69	19	28	23	37
August 09	13	25	26	43	15	30	45	68	14	28	31	47
September 09	16	22	33	48	16	29	52	87	15	23	44	69
October 09	18	28	43	66	18	32	66	90	17	29	57	82
November 09	18	31	50	74	20	39	59	93	19	43	67	108
December 09	17	26	72	96	18	35	99	138	19	43	110	140
January.10	15	24	70	96	19	32	104	138	18	38	111	139
February.10	16	32	100	131	19	39	135	168	18	36	113	146
March.10	15	27	87	119	19	36	129	178	17	34	98	126
April.10	14	26	56	94	17	30	101	130	16	26	68	98
May.10	16	26	39	74	17	25	62	99	18	25	39	71

Table 3 Comparison of Observed Annual Average Concentrations (μg/M³) With NAAQS (2009)

Year	Udyog Bhawan (Residential)			Kupwad MIDC (Industrial)			Rajwada Chowk (Commercial)		
	RSPM	SO_2	NO_x	RSPM	SO_2	NO_x	RSPM	SO_2	NO_x
2009-10	51	17	26	77	19	32	64	19	31
2010-11	56	11	29	75	12	30	67	12	32
2011-12	64	10	36	91	11	38	73	10	40
2012-13	70	10	39	97	12	43	78	11	44
2013-14	71	9	34	98	11	37	85	10	41
2014-15	72	12	45	103	13	44	90	12	50
2015-16	79	10	35	90	11	35	75	11	41
2016-17	76	8	38	79	9	39	75	9	49
AAQ*	**67.375**	10.875	35.25	**88.75**	12.25	37.25	**75.875**	11.75	41
*Annual arithmetic mean of a minimum of 104 measurements in a year at a particular site taken twice a week, 24 hourly at 8 hourly intervals expressed in μg/m³ .									
NAAQS (μg/m³)	60	50	40	60	50	40	60	50	40

It does not have provision for SPM as NAAQS [6]. The data with this background is transformed and is presented in Table 3. From Table 3, it can be seen that the parameter SO2 is substantially less as compared to the prescribed standard [7]. As compared to the concentrations observed in 2009, the concentrations observed in subsequent years are quite low [23]. This improvement could be due to mitigation measures taken to reduce sulfur in diesel and stringent enforcement by the government. A decreasing trend has been observed in sulfur dioxide levels in residential areas of many cities, such as Delhi, Mumbai, Lucknow, Bhopal, during the last few years. The decreasing trend in sulfur dioxide levels may be due to strict regulation of clean fuel standards, a shift to renewable energy, the growing substitution of LPG for fuelwood or coal in homes, as well as the usage of CNG in some cars in place of diesel. For Sangli city, absence of coal burning, refinery, and petroleum product-related industries could have caused lesser emissions of the parameter [8]. Several research studies (e.g. Chauhan et al., 2016; Kala et al., 2014; Dadhich, et. al., 2018) also reported similar observations. The presence of NOx is observed to be low as compared to the prescribed standard for it in year 2009-11. However, after that, for all three stations, the concentration is observed to be higher and tends to approach the prescribed limit [9]. Though its average value lies below the prescribed standard for residential and industrial areas, the reality could be different. NOx presence in the ambient atmosphere is not desirable because it is a major reactant to form photochemical smog. Also, it is an acute irritant and causes an appreciable reduction in visibility, in addition to other environmental damages. In the absence of the chemical industry, the source of NOx could be automobile exhaust in addition to combustion

operations in industrial areas [10]. During the study period, Sangli had no major industries dealing with Nitric acid manufacturing and very few dealing with furnaces [16]. Hence, appropriate steps towards automobile use and traffic planning may help to maintain this parameter within a permissible limit. The concentrations of RSPM are observed in the declining order of Kupwad MIDC (Industrial) > Rajwada Chowk (Commercial) > Udyog Bhawan (Residential) [11]. The concentrations observed to remain slightly lower during 2009–11 but always on the elevated side in subsequent years of the study period, as compared to the prescribed limit. In terms of suspended particle matter, most Indian cities significantly exceed permissible limits [12]. The ambient levels of SPM in most of the urban areas of India are above 150 µg/m3, which far exceeds the WHO standards of 50 µg/m3 (CPCB, 2000). This could be caused by burning agricultural biomass and roadside trash, vehicle emissions, fugitive dust emissions from poorly maintained roads, and improved earth movement techniques used in the construction sector and industrial sources, and automobile pollution (Vakeva, et.al. 1999; Shrivastava, et.al., 2013; Harison & Yin, 2000; Clarke, et.al., 1999) in and nearby Sangli region. Similar observations were reported by studies done in Delhi (George et al., 2013), Kolkata (Karar and Gupta, 2006), and Agra (Kulshrestha et al., 2009) [20].

Conclusion

The main objective of this study was to compare the observed air pollutant levels vis-à-vis national ambient air quality standards to ascertain whether the prescribed ambient air quality standards are being violated [13]. Out of the air pollutants, the CPCB has envisaged SO2, NOx, and RSPM being selected to assess National Ambient Air Quality [18]. The situation has improved in part because of the government's recent adoption of control measures to manage SO2 levels. The annual variability of the pollutants study indicates SO2 is not a matter of worry, but other pollutants are seeing their rising trend [14]. There is a need to establish stringent control over particulate and NOx pollutant levels. The local government has to design appropriate strategies to increase the awareness of the common man towards increased concentrations of pollutants and their harmful impacts [17]. Additionally, it has to devise appropriate preventive and corrective measures to promote environmental protection.

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